Local resolution of the flow field and the slip length of a superhydrophobic surface

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Superhydrophobic surfaces can provide a significant slip to a fluid flowing over the surface, making them attractive for the development of functional coatings. This slip is related to air being entrapped in the indentations of the structured surface that can act as a lubricant. Although the global behaviour of flow past superhydrophobic surfaces has been widely investigated, the local physical fundamentals leading to slippage still remain unclear.

Using fluorescence correlation spectroscopy (Fig. 1), we performed detailed measurements of the local flow field and the local slip length for water in the Cassie state on a structured superhydrophobic surface [1]. We revealed that the local slip length of a superhydrophobic surface is finite, non-constant and anisotropic. Furthermore, it can be strongly influenced by the presence of surface active substances.

All these properties can be explained by the local hydrodynamics within the air layer and at the air-water interface, such as the local flow field depending on the surface geometry or Marangoni forces. For this purpose, we performed numerical calculations of the flow that confirm the complexity of the local flow field found in the experiments.

On a more general level, these findings are also of relevance for the development of theoretical models of slippery surfaces that rely on a fluid being in the Cassie state, because to date, such models typically do not take into account the aforementioned properties of the local slip length.

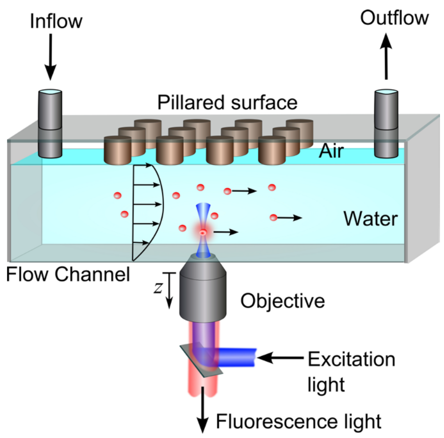

Figure 1 Schematic of the experimental setup.

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[1] D. Schäffel, K. Koynov, D. Vollmer, H.-J. Butt and C. Schönecker, Local flow field and slip length of superhydrophobic surfaces, Physical Review Letters, 116, 134501, 2016.